FIG. 1

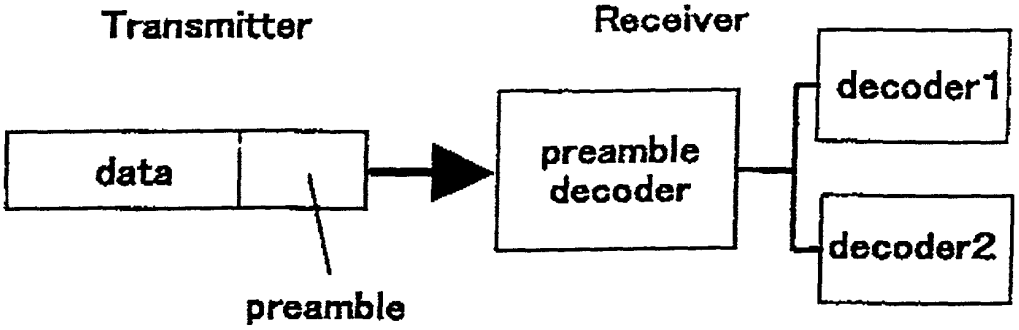

Transmitter
Receiver
data
preamble
preamble decoder
decoder1
decoder2

FIG. 2

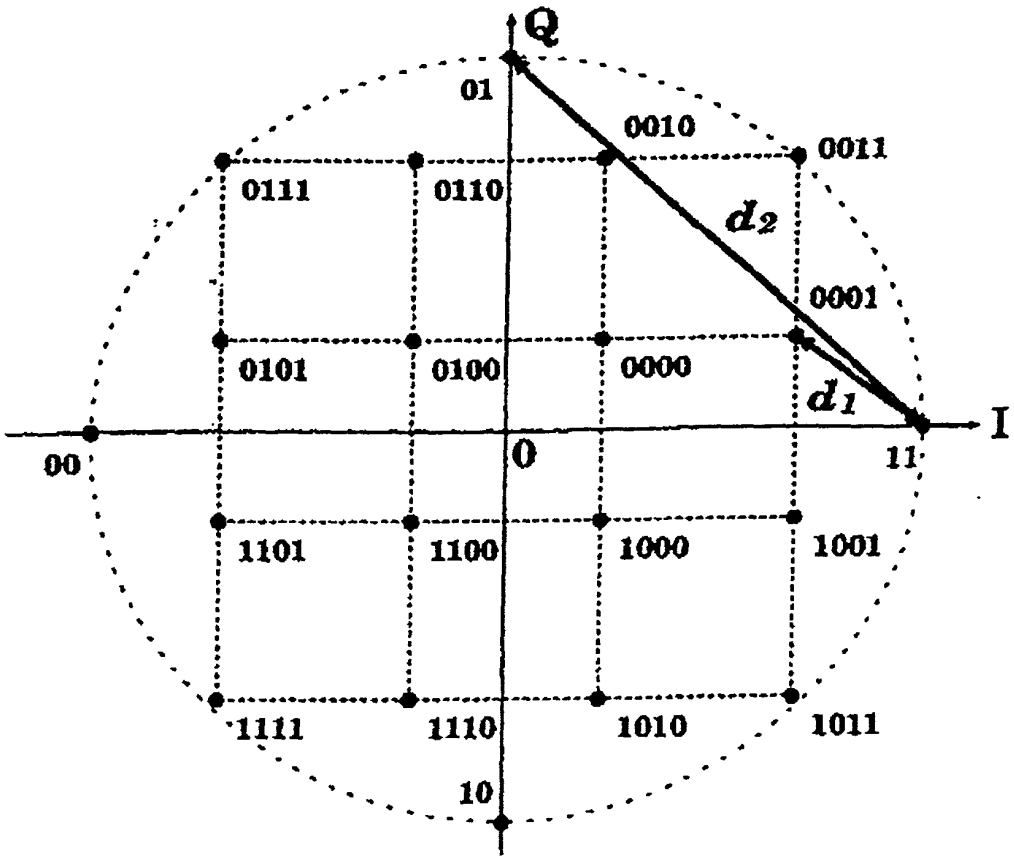
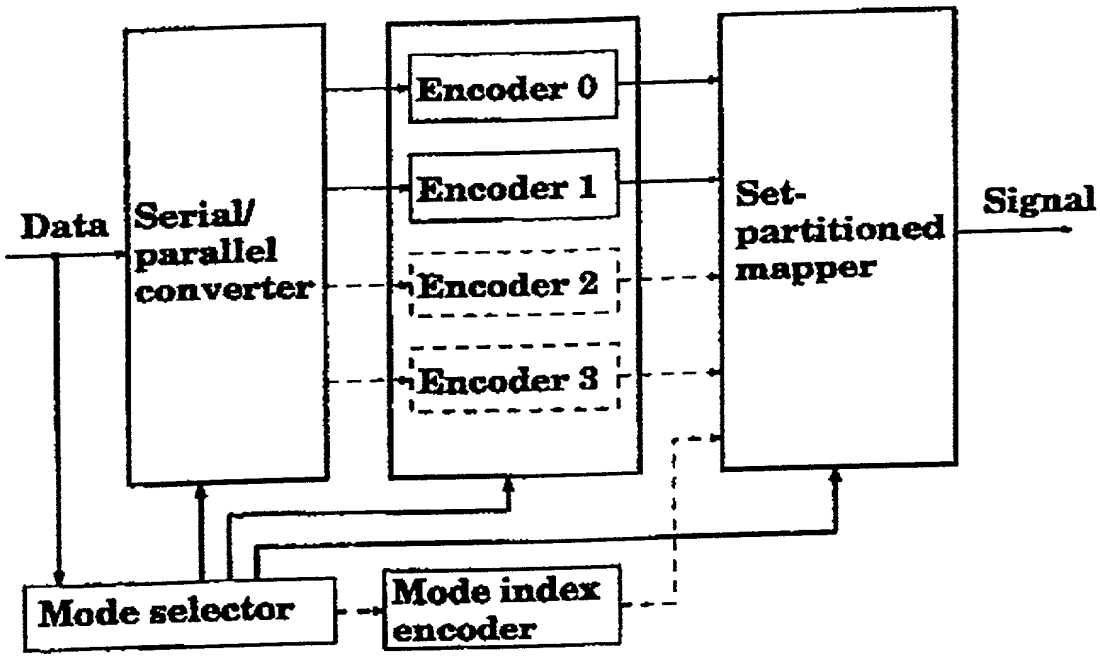
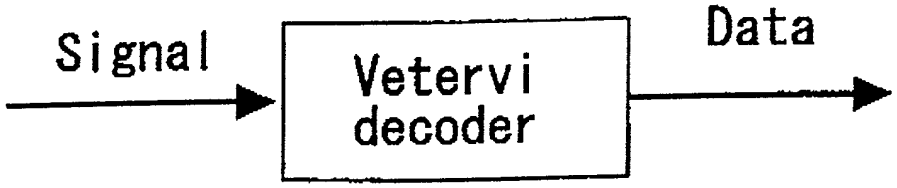

Q
I
01
0010
0011
0111
0110
d_2
0001
0101
0100
0000
d_1
00
0
11
1101
1100
1000
1001
1111
1110
1010
1011
10

FIG. 3



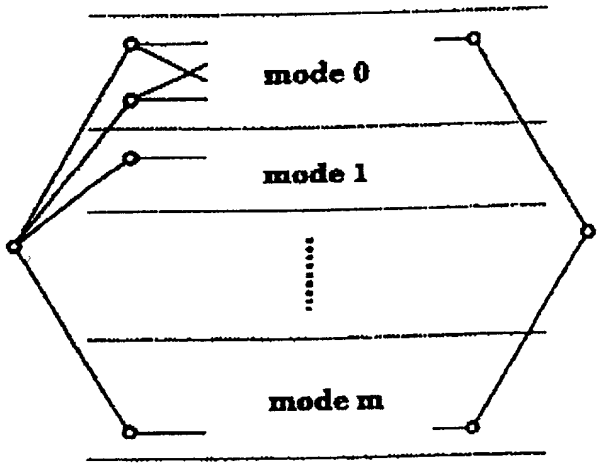
MULTI-MODE ENCODER

FIG. 4(a)



block diagram

FIG. 4(b)



trellis diagram

FIG. 5

	s1	s2		s (L-1)	sL
	$\overbrace{\quad}$	$\overbrace{\quad}$		$\overbrace{\quad}$	$\overbrace{\quad}$
l1	c_1	c_1		c_1	c_1
l2	a_1	a_2	-------	a_{L-1}	c_2
l3	a_L	a_{L+1}		a_{2L-2}	a_{2L-1}
l4	$\underbrace{a_{2L}}$	$\underbrace{a_{2L+1}}$		$\underbrace{a_{3L-2}}$	$\underbrace{a_{3L-1}}$

$c_1 = 0$ (mode 1), 1 (mode 2)

$c_2 = a_1 \oplus a_2 \oplus \cdots\cdots \oplus a_{L-1}$

FIG. 6

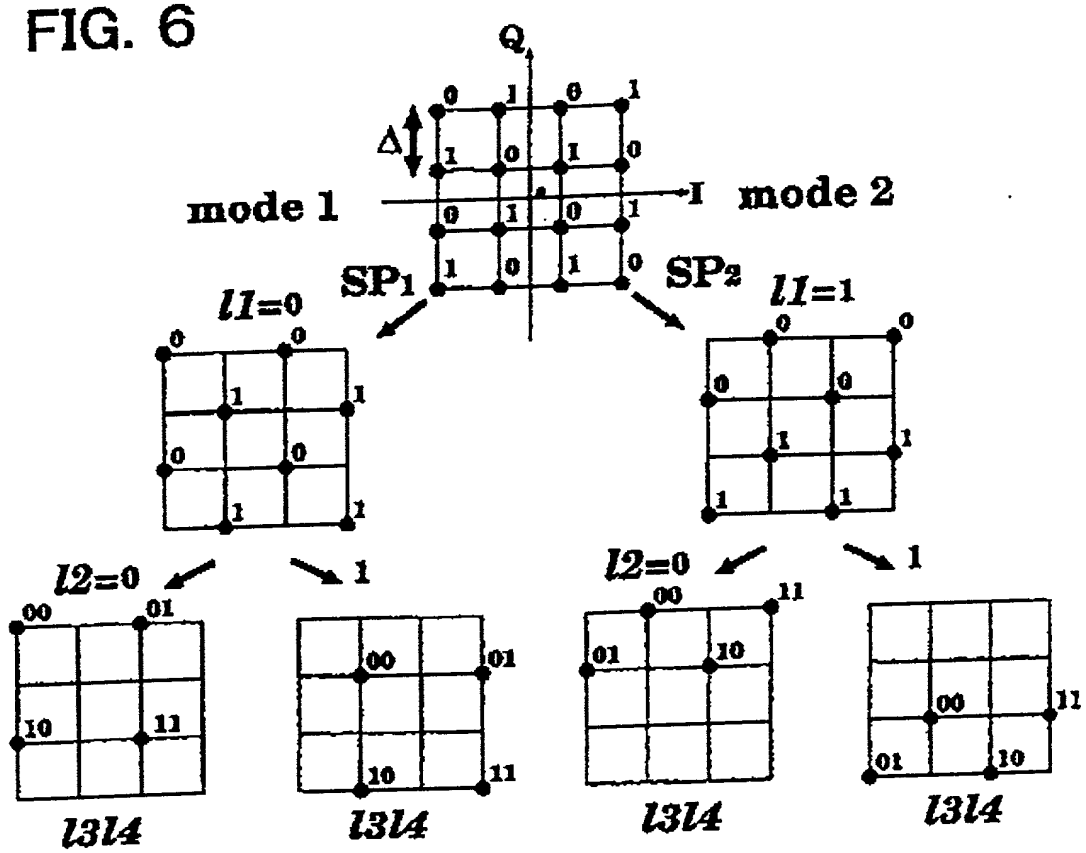

Q
Δ
mode 1
I
mode 2
SP1
SP2
l1=0
l1=1
l2=0
1
l2=0
1
l3l4
l3l4
l3l4
l3l4

FIG. 7

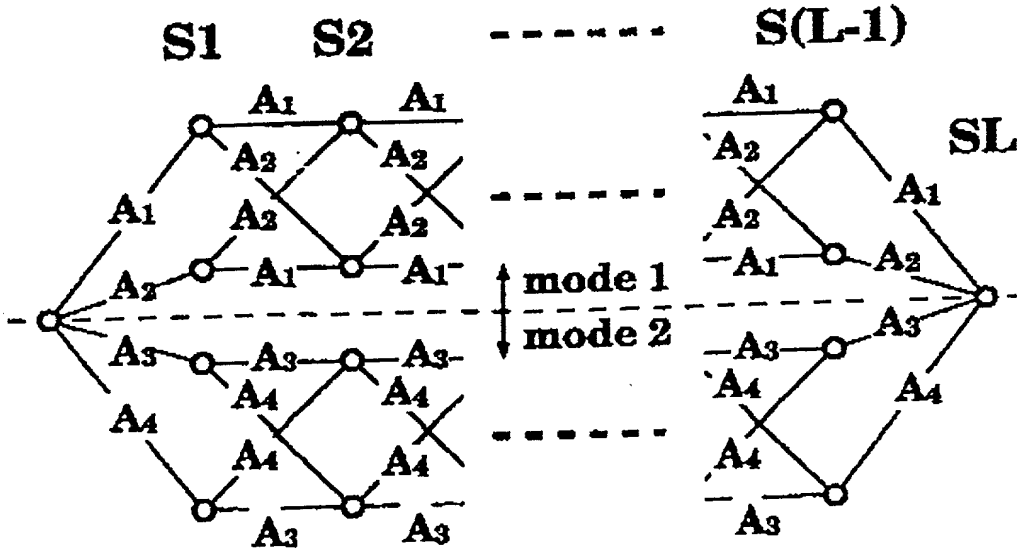

S1
S2
S(L-1)
SL
mode 1
mode 2

FIG. 8

	s1	sL'	s(L'+1)	s2L'	s(2L'+1)	s (L-1)	sL
l1	0	0	0	0	0	0	0
l2	a_1 ---	$a_{L'}$	$a_{L'+1}$ ---	$a_{2L'}$	$a_{2L'+1}$ --	$a_{3L'-1}$	c_1
l3	$a_{3L'}$	$a_{4L'-1}$	$a_{4L'}$	$a_{5L'-1}$	$a_{5L'}$	$a_{6L'-2}$	$a_{6L'-1}$
l4	$a_{6L'}$	$a_{7L'-1}$	$a_{7L'}$	$a_{8L'-1}$	$a_{8L'}$	$a_{9L'-2}$	$a_{9L'-1}$

mode 1

l1	0	0	1	1	1	1	1
l2	a_1 ---	$a_{L'}$	$a_{L'+1}$ ---	$a_{2L'}$	$a_{2L'+1}$ --	$a_{3L'-1}$	c_1
l3	$a_{3L'}$	$a_{4L'-1}$	$a_{4L'}$	$a_{5L'-1}$	$a_{5L'}$	$a_{6L'-2}$	c_2
l4	$a_{6L'-1}$	$a_{7L'-2}$	$a_{7L'-1}$	$a_{8L'-2}$	$a_{8L'-1}$	$a_{9L'-3}$	c_3

mode 2

l1	1	1	0	0	1	1	1
l2	a_1 ---	$a_{L'}$	$a_{L'+1}$ ---	$a_{2L'}$	$a_{2L'+1}$ --	$a_{3L'-1}$	$a_{3L'}$
l3							
l4							

mode 3

l1	1	1	1	1	0	0	0
l2	a_1 ---	$a_{L'}$	$a_{L'+1}$ ---	$a_{2L'}$	$a_{2L'+1}$ --	$a_{3L'-1}$	c_1
l3							
l4							

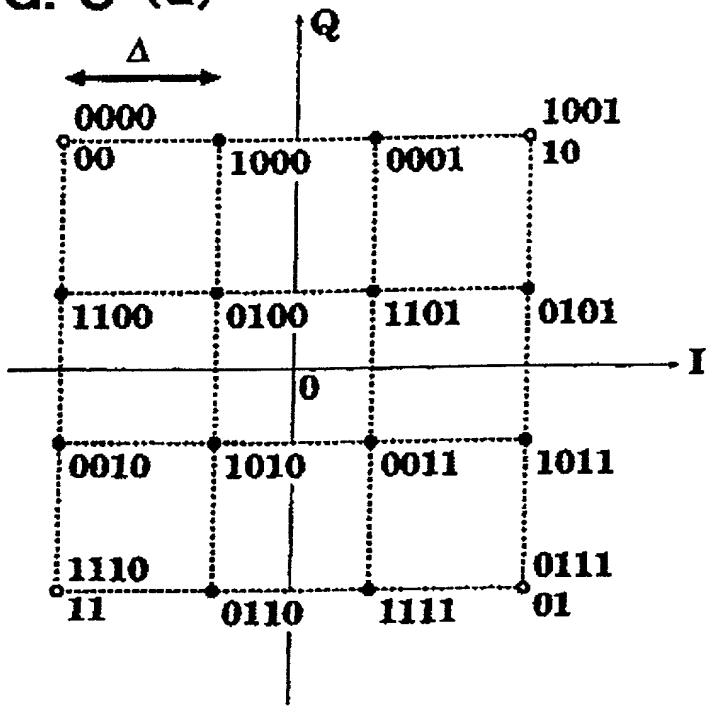
mode 4

$$c_1 = a_1 \oplus a_2 \oplus \cdots\cdots \oplus a_{3L'-2} \oplus a_{3L'-1}$$

$$c_2 = a_{3L'} \oplus a_{3L'+1} \oplus \cdots\cdots \oplus a_{6L'-3} \oplus a_{6L'-2}$$

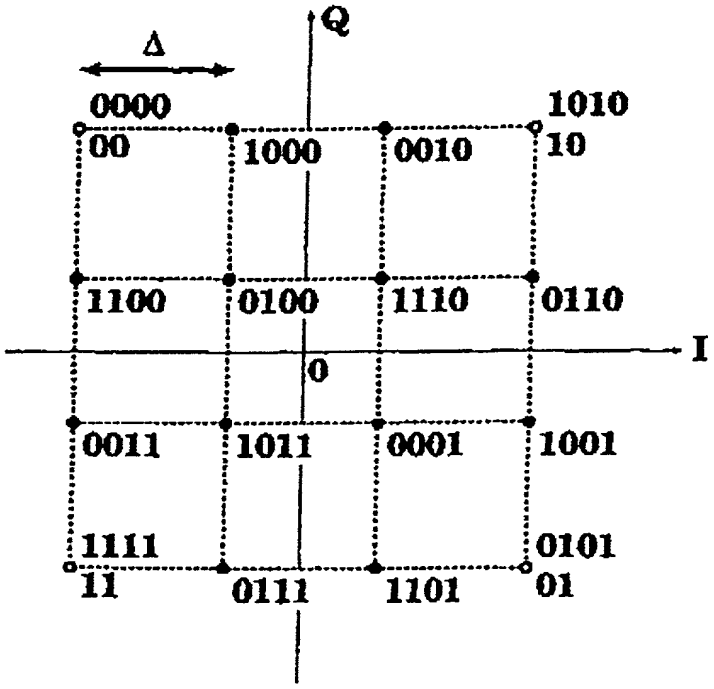
$$c_3 = a_{6L'-1} \oplus a_{6L'} \oplus \cdots\cdots \oplus a_{9L'-4} \oplus a_{9L'-3}$$

FIG. 9 (a)



mode 1 and 3

FIG. 9 (b)



mode 2 and 4

FIG. 10

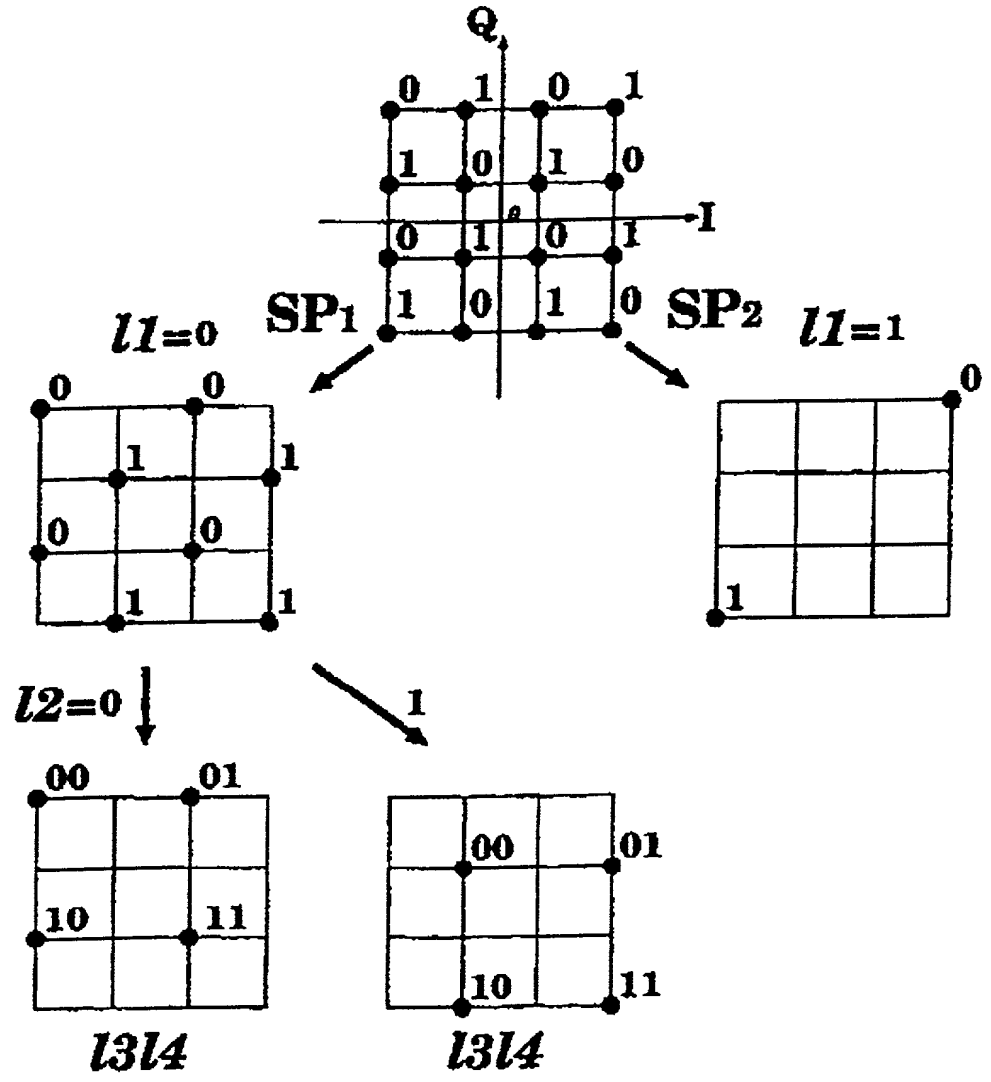
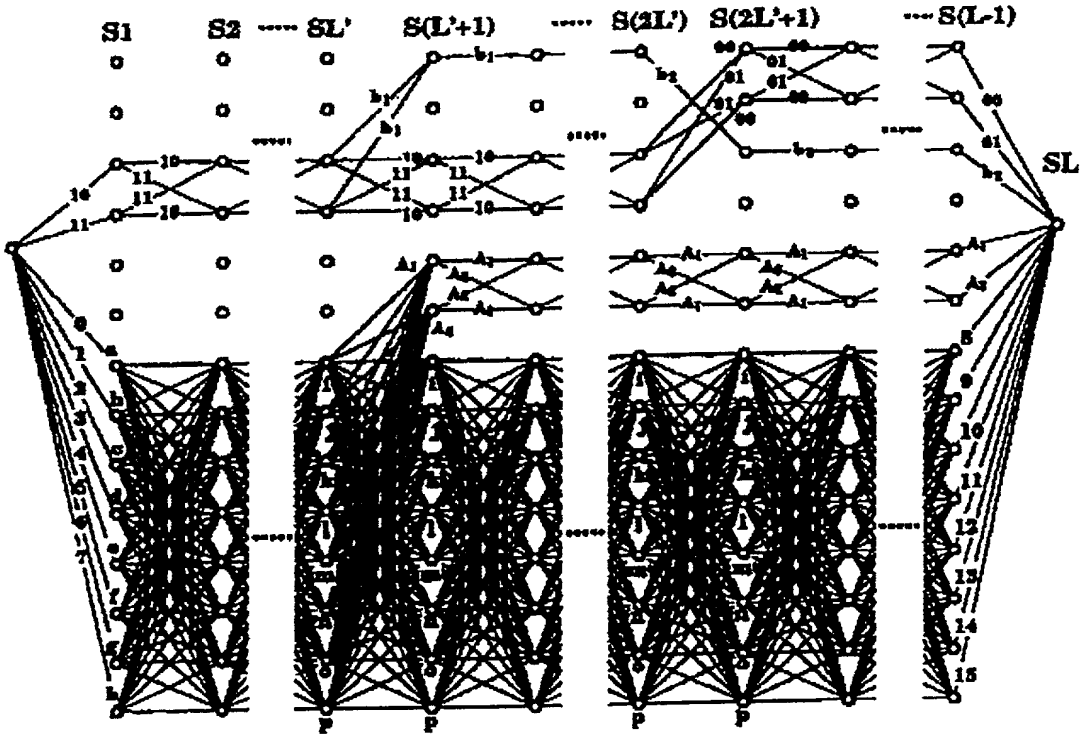


FIG. 11



Si

S(i-1)	a	b	c	d	e	f	g	h
a	0	1	2	3	4	5	6	7
b	1	0	3	2	5	4	7	6
c	2	3	0	1	6	7	4	5
d	3	2	1	0	7	6	5	4
e	4	5	6	7	0	1	2	3
f	5	4	7	6	1	0	3	2
g	6	7	4	5	2	3	0	1
h	7	6	5	4	3	2	1	0

Si

S(i-1)	i	j	k	l	m	n	o	p
i	8	9	10	11	12	13	14	15
j	9	8	11	10	13	12	15	14
k	10	11	8	9	14	15	12	13
l	11	10	9	8	15	14	13	12
m	12	13	14	15	8	9	10	11
n	13	12	15	14	9	8	11	10
o	14	15	12	13	10	11	8	9
p	15	14	13	12	11	10	9	8

FIG. 12

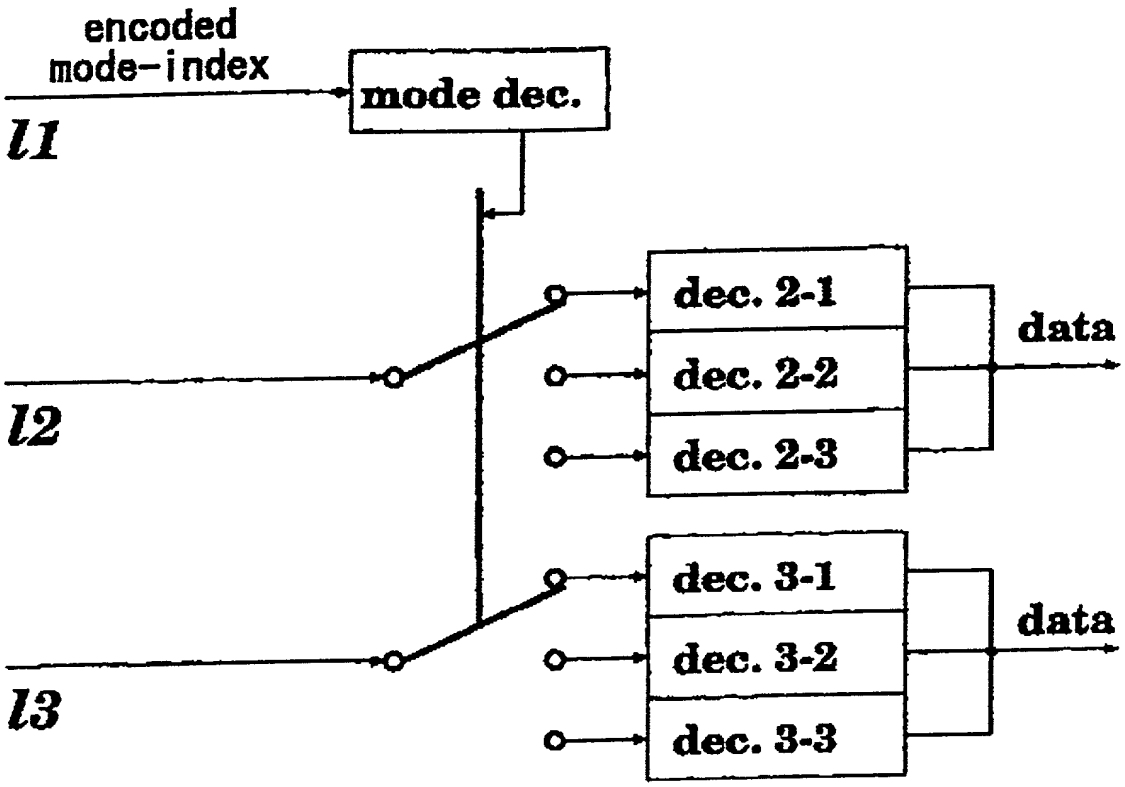

encoded
mode-index
l1
mode dec.
l2
dec. 2-1
dec. 2-2
dec. 2-3
data
l3
dec. 3-1
dec. 3-2
dec. 3-3
data

FIG. 13 (a)

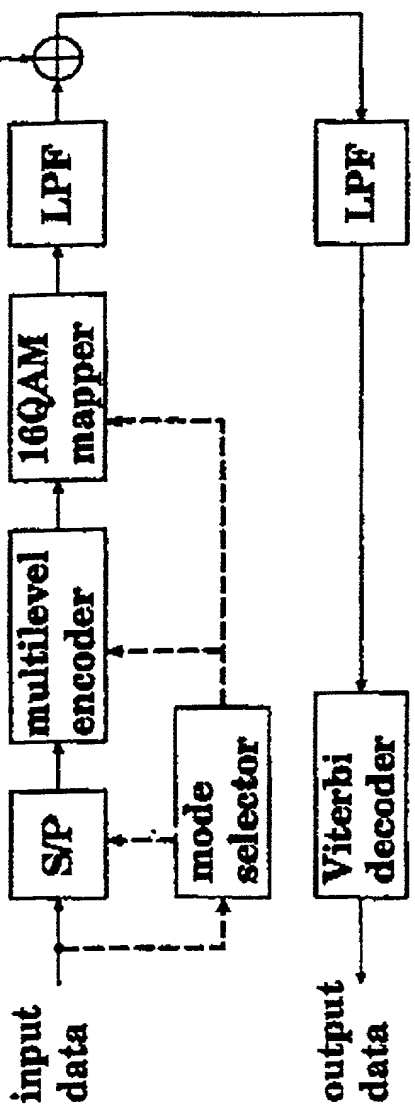


FIG. 13 (b)

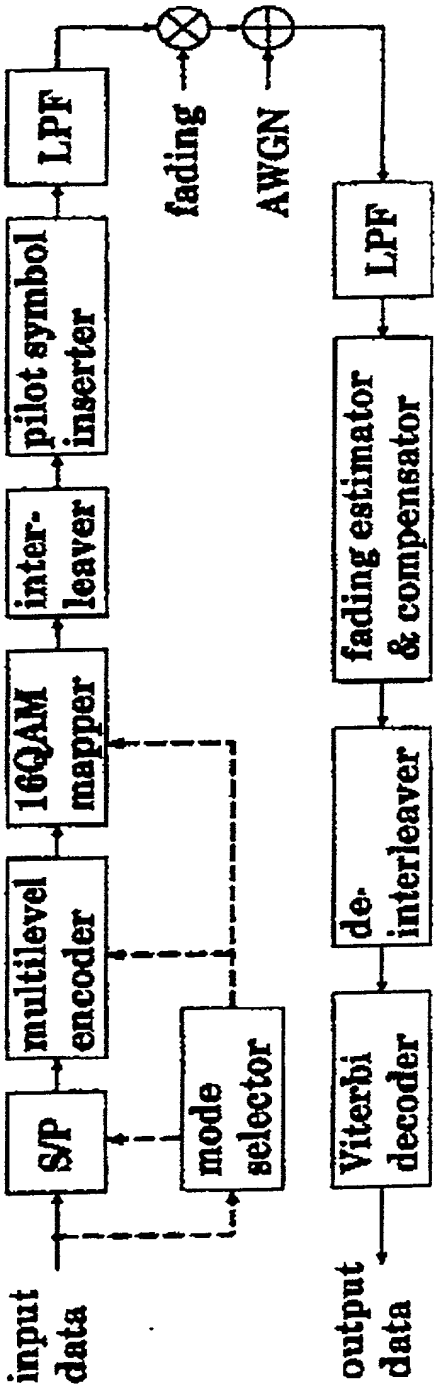


FIG. 14

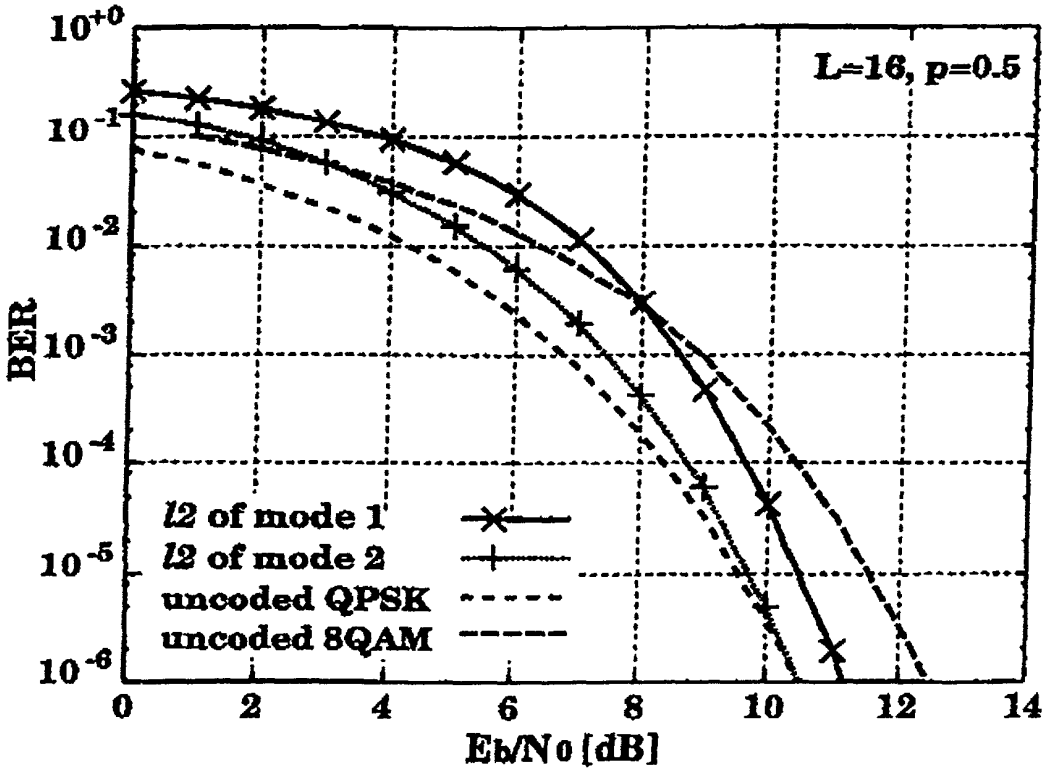

L=16, p=0.5
BER
Eb/No [dB]
l2 of mode 1
l2 of mode 2
uncoded QPSK
uncoded 8QAM
10+0
10-1
10-2
10-3
10-4
10-5
10-6
0
2
4
6
8
10
12
14

FIG. 15

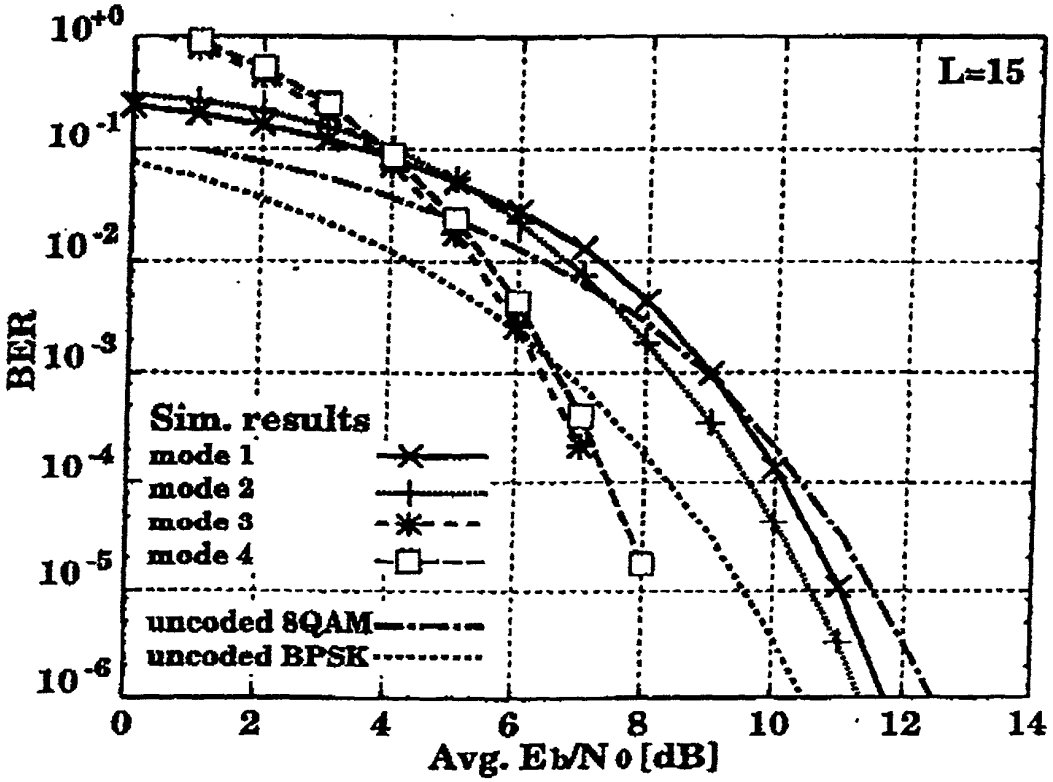
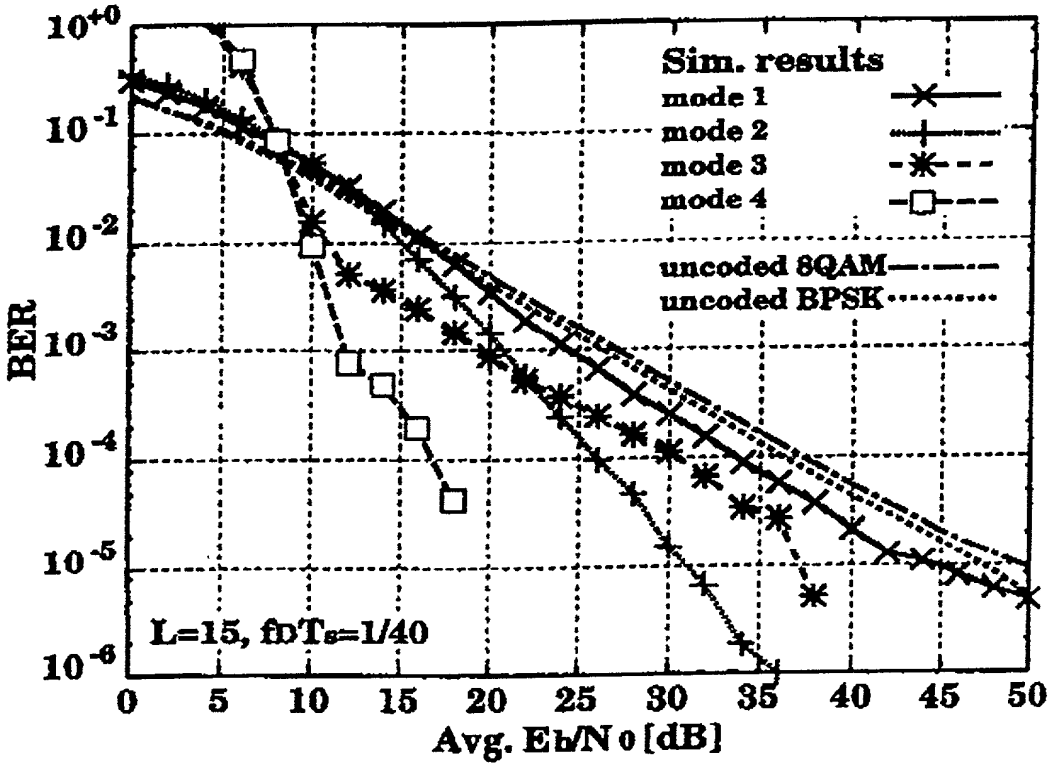

L=15
BER
Avg. Eb/N0 [dB]
Sim. results
mode 1
mode 2
mode 3
mode 4
uncoded 8QAM
uncoded BPSK
10+0
10-1
10-2
10-3
10-4
10-5
10-6
0
2
4
6
8
10
12
14

FIG. 16


Sim. results
mode 1
mode 2
mode 3
mode 4
uncoded 8QAM
uncoded BPSK
L=15, fDTs=1/40
BER
Avg. Eb/N0 [dB]
10+0
10-1
10-2
10-3
10-4
10-5
10-6
0
5
10
15
20
25
30
35
40
45
50